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ORGANIC COMPOST

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Ontario

Ministry
of the
Environment

The Honourable
Keith C. Norton, Q.C.,
Minister

Gérard J. M. Raymond
Deputy Minister

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ORGANIC COMPOST

Prepared by: Peter J. Provias
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ORGANIC COMPOST

Background

Compost is a stable humus or soil like product, the result of the biological decomposition of organic waste materials. Today, these organic materials will likely originate from municipal solid waste and/or sewage sludge alone or in combination.

Compost for years has been used by farmers in the far East to enhance organic depleted soils. Its use no doubt has been motivated in many cases by an inherent knowledge that the compost somehow could provide organic stabilization and nutrition.

Western countries developed on these early composting techniques so that by the early 1900's a more technical approach was taken to composting and by the mid 1900's there was an appreciation of the effect on composting of the main physical and chemical parameters as well as the micro-biological interactions.

The large scale monitored approach to compost production is a more recent phenomenon although one might consider the mushroom growing industry an exception simply because it has been producing composts from manures and straws for over one hundred years, developing a well structured industry incorporating all the innovations regarding ingredients, organic supplements and the large scale equipment needed to accomodate the demands of the industry. Compost produced by the mushroom industry is claimed by the industry to be exclusive to its own use to such an extent that compost produced by any other method is considered suspect.

During the past twenty-five years, there have evolved several accepted large-scale methods of producing compost on a scientific and monitored basis. The scientific approach has been motivated by the considerable attention devoted to planned techniques of municpal waste management in order to alleviate recurring problems of diminishing availability of landfill sites.

The Waste Management Branch of the Ministry of the Environment has long recognized specific problems of municipal waste management. One such problem has been the difficulty in obtaining acceptable sanitary landfill sites throughout Ontario thereby putting pressure on many urban and rural communities to look at alternative methods of solid waste disposal.

Integrated resource recovery, a combination of a number of process modules wherein the solid waste is treated to develop energy sources as well as to recover recyclable materials, has been one concept proposed to meet the requirements of certain areas in close proximity to well established markets. An example is the Experimental Resource Recovery Plant of the Ministry of the Environment located in Downsview. It processes 200 tonnes of municipal solid waste per day for recovery of materials including the production of compost.

Variations of integrated resource recovery plants have been put into operation mainly concerned with the removal of one or two recyclable materials with the remainder of the processed waste generally going to landfill, or in some instances for energy recovery.

The alternative of turning the organic fractions of municipal solid waste into a final compost after recyclable materials have been removed, was recognized and a compost module was incorporated in the Experimental Resource Recovery plant. Compost could be of interest in both urban and rural areas.

Such an alternative could be attractive to small communities generating in the order of 50 to 100 tonnes/day of waste. These communities are too small for full scale or even reduced and modified resource recovery operations and generally are too far removed from urban market areas for energy and recovered materials. They have little choice but to continue landfilling or finding alternatives such as producing compost and putting the product back into the land.

Although the benefits of disposal site conservation are known there is a possibility also of other benefits such as additions of nutrients, additional organic replenishment in the soil, and improved soil conditions.

However, such benefits must be balanced against the potential hazards of heavy metal contamination that might find its way into the productive land as well as the possible negative cost benefits of such operations.

Technology

Other than the established production of the compost within the mushroom industry, the two generally accepted systems for producing compost are:

1. - Enclosed continuous mechanical aerobic systems with oxygen and temperature controls. Such systems are marketed by several manufacturers, one being the Fairfield Engineering Company. This system has been installed at the Experimental Resource Recovery Plant of the Ministry of the Environment located in Downsview, Ontario.

2. - Open static piles of compostable organic materials commonly called windrows, the historical method of producing compost. Recently, aeration systems have been added to windrow composting to better control process conditions and eliminate the need for frequent turning of windrows.

In either system the material being composted is the organic fraction of household waste, paper products as well as many garden wastes including leaves, grass clippings, etc. Considerable work has also been done on the composting of sewage sludge and many windrow systems today are devoted solely to handling this product. For example, the West Windsor Pollution Control Plant, Windsor, Ontario operates a well monitored open aerated static pile or windrow system for composting its sewage sludge.

Experimental Resource Recovery Plant - Composting

The Experimental Resource Recovery Plant was opened by the Ontario Ministry of the Environment in 1978 with the object of finding ways to separate and reclaim or recycle the components of municipal solid waste.

A large portion (35%) of solid waste is made up of organic material. At the Experimental Plant, this material is separated from the other components of wastes and processed through the composting module.

Here the organic material is mixed with water in a pugmill to achieve the proper moisture content (50% - 60%) for composting. The wetted organic material is fed to a large closed mechanical digester 58 feet in diameter. Here augers are used to mix the mass of composting organic materials. A blower provides air to ensure that the decomposition process remains aerobic. This process generates temperatures in a range of 65°C to 70°C which are adequate to destroy pathogenic organisms, weed seeds, or insect eggs that might be in the waste. The five day digesting process is automatically controlled and fully monitored. After the five day cycle in the digester, the composted material is conveyed from the digester through screens to remove oversize materials and the screened compost is then discharged onto concrete pads where it receives final curing in an aerated static pile. It is then stored for shipping.

For an average input to the Experimental Resource Recovery Plant of about 200 tonnes per day of municipal solid waste, approximately 30 tonnes of organic fraction is used as feed to the digester; this represents the design capacity of the digester. Final output of screened compost averages about 50% of the discharge from the digester, or approximately 15-20 tonnes per day.

Whether or not organic compostable materials should be mechanically processed prior to the digesting treatment in either enclosed mechanical or in the open static pile system, is debatable. However, shredding of the municipal solid waste to a somewhat smaller uniform size, for example to minus 2 inches, will facilitate the physical handling and aeration of the material as well as the subsequent biological decomposition. Recyclable materials such as cans or galss should be removed for recovery prior to composting.

All processes depend upon material decomposing to a so-called "cured" or stabilized state. Bacterial activity beings in the controlled environment assisted by the mechanical turning of the material, with a result that the temperature rises to the 65°C to 70°C level where it remains until the readily decomposable material has broken down and the bacterial activity begins to decline. The process is complete when curing of the compost product has occurred and it is important to know when this stage is actually reached. Certain parameters help to determine the final curing stage. Probably the most practical one is knowing when the temperature starts to fall below the 50°C level. In addition, the texture of the final product should start to take on a dark brown color as well as an earthy texture.

The time to final curing actually differs little between the closed mechanical digester system and the open aerated static pile system. Although many manufacturers of the continuous closed system have claimed the five to seven day cycle in the closed digerster as being sufficient to effect stabilization, this has not proven to be the case in the Experimental Resource Recovery Plant experience. After five days in the digester, the material althought dark brown and earthy is still not cured but actually quite active and requires additonal time in windrows or static aerated piles to complete bacterial decomposition.

It is taken for granted that the open aerated static pile or windrowing system will take some time before its final curing is effected so the normal procedure is usually from one month to at least six weeks of piling and aeration even before partial drying takes place and before storage of the material is carried out.

Compost Guidelines

Several years ago (1978) the Ontario Ministry of the Environment along with the Ministry of Agriculture and Food prepared and issued guidelines for "Sewage sludge utilization on agricultural lands". These Guidelines* have placed the limit on a concentration of eleven heavy metals in waste water sludges applied to soils. Since some municipalities are now beginning to compost dewatered sludge for application on non-agricultural lands, this product would also be subjected to these guidelines.

The Federal Government has taken a similar stand through the Food Production and Inspection Branch of Agriculture Canada, Feed and Fertilizer Division. The sale of dry processed sewage sludge and composted sludge and/or composted organic wastes as soil supplements, are considered within the purview of the Fertilizer Act and Regulations administered by Agriculture Canada. *In July 1981, Agriculture Canada issued heavy metal guidelines (Table 1) which follow those heavy metal concentrations given in the Ontario 1978 (1981 revision) set of guidelines. It follows that a compost will be subject to these guidelines whether it is made from sewage sludge or from municipal solid waste organic components.

*"Guidelines for Sewage Sludge Utilization on Agricultural Lands"
Ontario Ministry of Agriculture and Food
Ontario Ministry of the Environment - April, 1978

Markets

Over twenty years ago large scale composting of municipal solid waste was considered the answer to waste disposal problems but such attempts ended in failure resulting in the abandonment of many of the facilities.

The composting process was considered a financial failure generally because the net cost per tonne of compost exceeded the cost of landfilling. Put another way, the value of the compost in the market place was so low that the revenue was not high enough to cover the cost of processing.

Markets were scattered, not very large, incurring excessive haulage cost for a product which had little credibility and value added features and had to compete against other available low cost materials. In many instances, a compost was considered as a product to be given away for the cost of haulage.

Over-optimistic economic analysis, lack of large markets, competition, availability of less expensive disposal alternatives as well as overstated claims of composting developers all led to a gradual loss of credibility as far as the composting process was concerned. Today, the increasing cost of waste disposal, the depletion of suitable land for sanitary landfills could well be the impetus needed to create interest again in municipal solid waste composting as a suitable waste management alternative.

Marketing - Experimental Resource Recovery Plant

Compost from the municipal solid waste organic components treated at the Experimental Resource Recovery Plant located in Downsview, Ontario has many desirable characterisitics. (Table II) These are as follows:

1. - There are no weed or disease carrying organisms as these have been destroyed by the high temperatures during the five day digestion cycle.

2. - The control process used at the Experimental Plant results in a consistent product.

3. - The humus like texture of the compost makes it suitable for addition to both clay and sand soils. The compost adds organic matter to sand soils and helps break up the clay soils.

4. - The compost contains some, though limited, residual nutrient values including nitrogen, phosphorous and potassium.

5. - The price is competitive with that of many manures or peats.

The physical characteristics, nutrient values, and average heavy metal analysis of the compost from the Experimental Resource Recovery Plant is given in Table II.

In our planning it was felt that we would make available the Experimental Resource Recovery Plant compost in bulk quantities only and leave additional processing for value adding to private enterpreneurs.

Additional processing in the plant might involve drying of the product to a lower moisture level and then pelletizing or granulating the product so it would then be suitable as an organic base from which a fertilizer product could be made. However, this is not a current priority and would at best recover the additional processing costs. Our interests at this time are to establish the credibility of the product in multiple non-agricultural uses which normally make use of soil amendments and/or soil conditioners. Since there are many potential applications in non-agricultural lands for compost, we have left for the future any extensive work that may be done with compost on lands used for crops or for pasture and which would require, under the guidelines, extensive heavy metal monitoring.

The following general fields of application have been chosen for market development using the organic compost produced at the Experimental Plant for Resource Recovery in Donwsview.

Category

1. Conservation Authorities
   - Parks, nature and forest preserves;
   - Soil conditioning, mulching.
2. Municipal Parks and Recreation Boards
   - Turf Maintenance;
   - Horticulture;
   - Soil conditioning, mulching.
3. Provincial Highway Maintenance
   - Embankment Maintenance;
   - Mulching.
4. Aggregate Companies
   - Land reclamation;
   - Soil conditioning.
5. Turf Farms
   - Soil conditioning.
6. Golf Courses
   - Turf Maintenance;
   - Soil conditioning.

- Soil conditioning;
- Mulching.

8. Manufacturers, Wholesalers, Retailers

- Blended soil products.

9. Residential

- Soil conditioning;
- Turf Maintenance.

Some of the specific applications within the above categories over the past 2 years are shown as follows:

Status

1. Conservation Authorities

Metropolitan Toronto Conservation Authority - Have purchased compost for use as a soil conditioner and mulch at their Clairville and Glen Major Conservation sites.

Royal Botanical Gardens, Hamilton - Purchases ERRP Compost Nov. 1981 for mulching horticultural gardens.

2. Municipal Parks and Recreation Boards

Metro Toronto Parks Board - Trial load of compost applied at Ashbridges Bay Park. Will consider purchase in 1982.

Ministry of Gov. Serv. Horticultural Section - Trial loads supplied for application around several government buildings.

3. Provincial Highway Maintenance

Ministry of Transportation & Communication - Trial load supplied to Ministry for evaluation as a mulching material and for tree planting along highways.

4. Aggregate Companies

T. C. G. Material Ltd Brantford, Ontario - Trial loads supplied to T. C. G. Company for testing on gravel pit reclamation at Brantford, and other sites. Still under investigation.

Other aggregate companies have shown interest.

5. Turf Farms

J. Dol & Sons Limited, Cooksville - Trial load supplied for test work on turf growing and hydro-seeding.

Waterdown Sod - Trial load.

University of Guelph Experimental Farm, Hespeler, Ontario - Turf growing tests using ERRP compost funded by an MOE research grant. Finish spring, 1982.

Other Turf Farms under consideration.

6. Golf Courses

Ontario Golf Superintendents Association - Several golf courses considering ERRP compost for soil conditioning and top dressing trials.

7. Nursery Farms

Peter Braun Nursery, Mount Hope - Several trial loads, currently being assessed for farm nursery stock.

Blue Sky Nursery, Grimsby - Purchase compost for horticultural uses.

Sheridan Nurseries - Will assess the ERRP compost in spring, 1982 under a testing program at 2 of their farms.

Waterdown Nurseries - Will assess the compost as a horticultural and top-soil amendment in spring, 1982.

Weall & Cullen, East Toronto - Trial load of compost for winter of 1982 for testing as horticultural and soil amendment.

John Cannon, Waterdown - Trial bags of compost for testing in greenhouses through 1981/82. Use for horticultural applications.

8. Manufacturers, Wholesalers, Retailers

Hillview Farms, Woodstock - Has purchased large quantities of ERRP compost for trial purposes.

J. A. Ogilvie & Sons, Caledonia - May evaluate in 1982, as a blending agent with othe soil products.

W. R. Grace Limited, Toronto - May evaluate ERRP compost as a blending agent with other potting soils and peats.

C. I. L., Stoney Creek - Interest as a fertilizer base.

Other Agencies

Underway are several research projects aimed at developing data which will be of some use in establishing credibility in the market place.

1. Field trials at the Ridgetown College of Agricultural Technology where compost has been applied in bulk quantities to corn growing fields and is being compared to normal practice. Both sandy and clay soils are being conditioned with the compost. Emphasis is on growth monitoring as well as soil and plant heavy metal uptake.

2. Research at the University of Guelph. Horticultural and Turf growing sections to:

    i) Study effect of compost as a mulch for germinating and sustaining new and old turfs;

    ii) Establish compost as a potting or container growing medium, for nursery use;

    iii) Undertake trials to establish compost as soil amendment for land cultivation and reclamation. To be done on nursery farms and at least one abandoned gravel pit site.

    iv) Vineland Research Station - Vineland
    E.R.R.P. compost has been applied as a casing material for the growing of mushrooms during the final stage. Generally a sterilized top-soil blend is used for the casing material.

European Market Experiences

Often it is claimed that utilization of organic compost in Europe is far advanced. A recent survey* of such operations in Europe showed that although compost is utilized in some specific areas and countries it is not done on a very large scale. For instance, the only large application of compost is in so-called "Luxury" agriculture; the vineyards of Germany and France where it is used only for erosion control of the steep sloping vineyards. This takes only a very small portion of the total waste being generated.

There is very little use of compost in basic agriculture for crop growing mainly because of costs and potential heavy metal contamination. Horticulture, re-cultivation of reclaimed lands and landscaping uses are more prevelent in the Netherlands and Switzerland but even here the amount used, compared to the waste generated, is very small.

Restraints to Market Development

Compost by nature is a seasonal product and all market development is governed by that fact. The short planting periods of spring and fall are normally busy for those involved in landscaping, gardening, horticultural and of course farming in general.

Field research with the compost must also be conducted during the short busy periods, and in some cases, has to be extended over several seasons. Greenhouse research has been conducted by the University of Guelph during the off seasons (winter), but even here the work should be augmented by field studies.

Potential users of the product are reluctant to consider large scale use; e.g. bulk applications over the land for purposes of soil conditioning, and land reclamation, without first having some indication of its potential usefulness.

Although organic compost has some nutritional value, it cannot be considered an organic fertilizer. Competitive products on the market place, whether they are peat moss mixtures, top soils, manures or inorganic fertilizers, are in most cases, quite reasonable in price per unit of nutrient and available in bag or bulk, thus putting much pressure on the pricing of the compost.

For instance, some manures are free for pick-up, others may cost from $2 to $5 per cubic yard; peat moss anywhere up to $20 per cubic yard; pine-barks from $3 to $4 per cubic yard; top-soils up to $85 for an 8 cubic yard load.

Bagged products command higher prices, but to justify the additional steps of bagging, product should meet the requirements of the market-place. It is not the intent of the Experimental Resource Recovery Plant to bag its compost on site but rather to have some entrepreneur do this at some later stage of product development, likely using the compost as a component of bagged soil products.

The selling price of the E.R.R.P. compost must compete with similar products, as well as meet the requirements of the potential end-users. To date, some of the compost has been sold in bulk both F.O.B. plant as

*Survey of European Composting Practices,
Ministry of Environment, July 1981

well as user site at prices from $3.50 per cubic yard to $10 per cubic yard. A price of $3 to $4 per cubic yard will cover shipping cost up to 75 miles.

Of concern to many potential users, is the possibility of heavy metal contamination should large amounts of compost be used on the land. To date in using the compost from the Experimental Resource Recovery Plant, there does not appear to be any problem with heavy metal contamination, although this might occur if sewage sludges were used for the compost feed, in which case care should be taken to monitor the source and type of sludge to be composted.

Comments

Although the present status of large scale commerical composting, particularly of municipal solid waste and/or processed waste water sludges, is not well established the fact remains that interest is beginning to mount in the use of such a product.

Large scale users of organic compost must be developed and the most likely applications are in the areas of: land reclamation (gravel pits, etc.), horticulture (farms and nurseries), conservation preserves, and some agricultural lands.

Credibility is of primary importance to establish the usefulness of the product as well as a realistic market price. This is being done through the efforts of the Waste Management Branch of the Ministry of the Environment utilizing the compost product from the Experimental Resource Recovery Plant.

TABLE I

Metal	Maximum Acceptable Metal Concentrations in Processed Sewage, Sewage-Based Products and other By-Products Containing 5% N or Less Represented for Sale as Fertilizers or Supplements	
Arsenic	75	mg/kg
Cadmium	20	mg/kg
Cobalt	150	mg/kg
Mercury	5	mg/kg
Molybdenum	4	mg/kg
Nickel	180	mg/kg
Lead	500	mg/kg
Selenium	14	mg/kg
Zinc	1850	mg/kg

N. B.: Acceptable concentrations in these products increase proportionally with total nitrogen content above 5%.

The maximum acceptable metal concentrations in Table I are based on an assumption of a cumulative total application to soil or 200 tonnes per hectare of a 5% nitrogen product. Such a product, applied annually at a rate of 220 kg N/ha (or 4400 kg product/ha) would reach the following maximum acceptable cumulative metal additions to soil within 45 years.

Metal	Maximum Acceptable Cumulative Metal Additions to Soil	
Arsenic	15	kg/ha
Cadmium	4	kg/ha
Cobalt	30	kg/ha
Mercury	1	kg/ha
Molybdenum	4	kg/ha
Nickel	36	kg/ha
Lead	100	kg/ha
Selenium	2.8	kg/ha
Zinc	370	kg/ha

These metal concentration standards are adopted as a result of long-term effects of heavy metals in soils. Some metals are relatively phytotoxic: other toxic to animals or man. Some of the non-essential metals have long-term cumulative effects which are not fully understood.

ORGANIC SOIL CONDITIONER

Produced at Ontario Ministry of Environment's
Experimental plant for Resource Recovery

CHEMICAL AND PHYSICAL PROPERTIES

Nitrogen	1.1%
Phosphorus	0.3%
Potassium	0.2%
Sodium	0.4%
Carbon (total)	23 %
pH	7.9%
Moisture	50 %
Ash	57 %
Bulk Density	550 kg/m^3
Water Holding Capacity	3 x dry weight
Conductivity	1000 umhos/cm

TRACE ELEMENTS

(Acceptable Addition to Agricultural Land)

Trace Elements and Concentrations* (ppm) Dry Weight Basis		**Maximum Acceptable Metal Addition to Soil****		**Allowable Soil Conditioner Addition*****	
		lbs/acre	kg/hectare	Tonnes/Hectare	Tons/acre
Arsenic	2.7	13	15	11,000	5,000
Cadmium	7.7	1.4	1.6	420	189
Cobalt	7.4	27	30	8,100	3,645
Chromium	244	196	220	1,800	810
Copper	641	150	168	520	234
Mercury	2.7	0.8	0.9	670	300
Molybdenum	22	3.4	3.8	350	158
Nickel	145	32	36	500	225
Lead	655	84	94	290	130
Selenium	0.6	2.4	2.7	9,000	4,050
Zinc	965	324	363	750	338

* Determined by acid extraction.

** "Guidelines for Sewage Sludge Utilization on Agricultural Lands" Ministry of Environment, April 1978, Revised March 1981.

*** Allowable addition calculated "as is" soil conditioner with 50% moisture.

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